

The shoulder-girdle is described and restored, and found to consist of interclavicle, clavicles, sternum, coracoids, pre-coracoids, and scapulæ. The scapula is in plan like *Kistecephalus*. The nearest approach to the coracoid and pre-coracoid is found among the monotreme mammals. The clavicle extended along the anterior margin of the scapula, and made an angular bend, so as probably to meet the interclavicle. The interclavicle appears to meet the lateral margins of the coracoids and not to overlap them in front. It approximates in form to the bone in *Ornithorhynchus*, *Ichthyosaurus*, and certain lizards, but is relatively much larger, and is larger than the interclavicle of *Stereorachis*. The sternum, which is transversely extended, is better compared with that of a lizard or Dinosaur. The shoulder-girdle as a whole is intermediate between monotreme mammals and known reptiles, but with the former type predominating.

The bones of the fore-limb are described in detail, and found to be relatively long and slender and generically unlike *Dicynodon*. The carpus is complicated. There are only two phalangeal bones in each digit, the second bone being a well-developed claw.

Finally a restoration is given of the aspect of the animal.

VII. "On the Modifications of the First and Second Visceral Arches, with especial Reference to the Homologies of the Auditory Ossicles." By HANS GADOW, Ph.D., M.A., Strickland Curator and Lecturer on Comparative Anatomy in the University of Cambridge. Communicated by Professor M. FOSTER, Sec. R.S. Received April 12, 1888.

(Abstract.)

The phylogenetic development of the first visceral arches shows us some most interesting changes of function, which we can follow upwards from the lower Selachians to the highest Mammals.

Originally entirely devoted to respiration as gill-bearing structures, the whole hyoidean arch becomes soon a factor in the alimentary system. Its proximal half forms the hinge of the masticatory apparatus, its distal half remains henceforth connected with the process of deglutition. Then this suspensorial arrangement is superseded by a new modification; the hyomandibula is set free and would disappear (it does nearly do so in Dipnoi and certain Urodela), unless it were made use of for a new function; with its having entered the service of the conduction of sound, it has entered upon a new departure, and it is saved from degeneration. The whole system of the one to four elements of the middle ear, which all have the same function as conductors of sound, is to be looked upon as *one* organ of *one* common

origin, namely, as a modification of the hyomandibula, the primitive proximal paramere of the second visceral arch.

Successive Modifications of the Mandibular and Hyoidean Visceral Arches.

I. Primitive condition (Notidanidæ). The palato-quadrate bar alone carries the mandible. The second arch is indifferent. Hyomandibula and quadrate (the palatine part is an outgrowth) are both attached to the cranium.

II. The hyomandibula gains a fibro-cartilaginous connexion with the mandible, the masticatory apparatus becomes amphistylic and occasionally hyostylic (Rajidæ, most Selachians).

The hyoid gains a cranial attachment (many Rajidæ).

III. The quadrate- or autostylic suspensorium becomes preponderant; the hyomandibula is, as in Teleosteans, divided into a proximal and into a distal (symplectic) element. The proximal part is received into a fenestra of the otic capsule, and is converted into a stapes, whilst the distal half either remains (*Proteus*, *Siren*, *Menopoma*) or is lost (other Urodela). The whole hyomandibula would have been lost owing to its exclamation from suspensorial functions, unless it had entered the auditory service.

IV. The autostylic arrangement prevails. The whole hyomandibula remains, gains an attachment on the "tympanum," and differentiates itself into several conjointed pieces, notably stapes or columella proper, and extra-columella or malleus.

The extra-columella gains connexion with the parotic cartilage; this connexion frequently remains, but in *Anura* alone it contains a special element of probably parotic origin.

The quadrate forms an important part of the tympanic frame.

IVa. Collateral departure of the *Anura*. The connexion between the tympanal part of the hyomandibula with the mandible is lost.

V. The quadrate still forms the principal suspensorial part of the mandible. The extra-columella, or malleus, retains for a long time its previously acquired connexion with Meckel's cartilage (*Amniota*).

Va. The top end of the hyoid is attached to the cranium (*Geckos*, *Mammalia*), and is occasionally fused with the extra-columella (*Hatteria*).

Vb. Or, the proximal portion of the hyoid is removed from the skull and remains otherwise well developed (most *Lizards*); or its proximal portion becomes reduced and lost (*Chelonia*, *Crocodylia*, *Ophidia*, *Aves*).

Vc. The extra-columella gains an attachment to the quadrate, squamosal, or pterygoid, whilst its connexion with the mandible (*Ophidia*, *Chamaeleon*), and the tympanum, is lost.

VI. The quadrate gradually loses its articulation with the mandible; the latter gains a new outer articulation with the squamosal;

the quadrate acts almost entirely as a tympanic frame. Incus and malleus fuse sometimes with each other, and lean on to the parotic region. The masticatory joint is doubly concave-convex (*Monotremata*).

VII. The quadrate is converted into the principal part of the tympanic frame, viz., annulus tympanicus. The mandible has lost its articulation with the quadrate, and the masticatory joint is a single concave-convex one, the convexity belonging to the mandible (*Mono-delpkia*).

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